REMOTE SENSING OF SURFACE CURRENTS ASSOCIATED WITH THE CHESAPEAKE BAY OUTFALL PLUME USING A SHORE-BASED HF RADAR

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LONG-TERM GOAL

To understand the dynamics and temporal and spatial variability of the dynamics of the outflow plume and its subsequent transition to a coastal jet using the combination of VHF/HF radar observations as well as additional moored, shipborne and remotely sensed data.

SCIENTIFIC OBJECTIVES

The objectives of this research are:

1. To characterize the space/time scales of the outflow plume variability embedded within a mesoscale flow regime;
2. To interrelate remotely-sensed signatures from OSCR/INSAR/Ship radar measurements by examining the salinity front and buoyant jet trapped against the coast;
3. To estimate horizontal advection, shear and vorticity associated with the mean and tidal flows;
4. To assess horizontal mixing effects between the fresh water from the outflow plume and the coastal ocean through the interaction of various current components; and
5. To examine the residual patterns of the surface layer outflow and how they are influenced by varying wind regimes.

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APPROACH

HF radars provide a unique opportunity to measure surface currents, surface gravity waves and wind speed and direction at high spatial and temporal resolution and over a large domain. The HF mode of the OSCR system was deployed for two months (October and November 1997) at Fort Story (Cape Henry) and the US Navy Fleet Combat Training Center Atlantic. These locations were chosen to catch the plume as it emerges from the bay and turns southward due to ambient flow and Coriolis forcing. Two additional HF radars, the SeaSonde system (Naval Postgraduate School) and the multi-frequency system (University of Michigan) were colocated with the OSCR. This study will permit intercomparison of three HF radar systems with different technical implementations, namely, single frequency, linear phased-array, single frequency, direction finding technique and the multi-frequency, linear phased-array.

WORK COMPLETED

Completed works include:

1. A data report describing the OSCR measurements for the first Intensive Observation Period of COPE-I (September 1996) is completed;
2. All surface vector currents have been processed and quality controlled. From this data set we computed tidal currents, mean (low-pass), band-pass and high-pass current fields;
3. All Doppler spectra for the month long measurement period (COPE-I) have been processed and information of the energy in the first and second-order peaks were extracted and tested for computations of wave heights;
4. Two month measurement program for COPE-III is almost complete; and
5. Several tests have been made with a transponder to establish array beam patterns.

RESULTS

Preliminary results show the presence of a strong outflow plume. During this time period, intense rainfall periods (tropical storms) produced record fresh water inflow into the Bay. The location of the OSCR measurements captures the turning of the plume as it emanates from the Bay. In a previous study of the plume further south as a coastal buoyant jet, we were able to quantify the spatial characteristics of the jet which is not possible in such detail with either point measurements or ship transects (Haus, et al. 1997). Our results also show a strong M_2 tidal component (> 80 cm/s) for this region. For COPE-III we used the same HF radar coverage which we can use to compare the tidal and plume characteristics during a high and low fresh water outflow conditions.

IMPACT/APPLICATION

The studies of high resolution surface current and wave height estimates with HF radar systems provide a continuous new look at small-scale dynamics affecting coastal and nearshore processes. From the tidal analysis we can describe the spatial variability of the dominant tidal components in this region. In particular our measurements show the directivity of the tidal flow as a function of offshore distance as well as the domination of a single tidal component (M_2) versus mixed tidal conditions.

TRANSITIONS

We collaborate with both NRL-Washington and NRL-Stennis in providing surface current measurements for the analysis of other remote sensing, shipboard and in-situ measurements.

RELATED PROJECTS

The measurements of the surface currents of the outfall plume and subsequent buoyant coastal jet provides crucial ground-truth for RAR and SAR imagery collected by NRL scientists. The present experiment will provide a unique data set of the same outflow plume conditions by three different HF radar systems.

REFERENCES

Haus, B.K., H.C. Graber, L.K. Shay, & S.J. Lentz, 1997. "Response of a coastal buoyancy current to varying wind regimes," Submitted to *J. Geophys. Res*.